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A research article

Vaginal cleansing and postoperative infectious morbidity in vaginal hysterectomy. A register study from the Swedish National Register for Gynecological Surgery.

by

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Running title: *Vaginal cleansing and postoperative infections*

Abstract

Objective: To evaluate whether preoperative vaginal preparation routines influence postoperative infectious morbidity in vaginal hysterectomy and to analyze risk factors for postoperative infectious morbidity.

Design: Retrospective, longitudinal cohort study.

Setting: Forty three hospitals in Sweden, participating in the Swedish National Register for Gynecological Surgery.

Population: All 6496 women who were enrolled in the Register and underwent vaginal or laparoscopically assisted vaginal hysterectomy between January 1, 2000 and February 1, 2008.

Methods: Register data were collected prospectively using doctors' forms and patient questionnaires. Information about vaginal preparation routines in the clinics were achieved retrospectively by an e-mail survey. Multiple logistic regression analyses models were used to determine associations and risk factors.

Main outcome measures: Infectious morbidity within 6 – 8 weeks postoperatively

Results: No significant differences were seen in postoperative infectious morbidity at long term between vaginal preparation using saline or chlorhexidine solution or no cleansing. At discharge from hospital those who had had vaginal cleansing using saline solution had a significantly higher risk of postoperative infections. Risk factors for infectious morbidity were young age, obesity, preoperative injury of urinary bladder, operative time, duration of hospital stay and protective factors were prophylactic antibiotics and concomitant prolapse surgery.

Conclusions: This study indicates that saline solution should not be used for vaginal cleansing due to a higher risk of infectious morbidity in the immediate postoperative period. Infectious morbidity may be reduced further by employing preventive measures such as

meticulous surgical technique, preoperative weight reduction in obese women and minimizing time in hospital.

Keywords: Postoperative infection; register study; risk factors; vaginal cleansing; vaginal hysterectomy.

Abbreviations

BMI body mass index

CI confidence interval

LAVH laparoscopically assisted vaginal hysterectomy

OR odds ratio

POP pelvic organ prolapse

SD standard deviation

UTI urinary tract infection

Introduction

Infectious morbidity is a common postoperative complication after hysterectomy for benign conditions (1). In a large prospective Finnish register study encompassing more than 10 000 hysterectomies, the overall complication rates were 17.2, 23.3 and 19.0%, respectively for abdominal, vaginal and laparoscopic hysterectomy. The corresponding infectious morbidity rates were 10.5, 13.0 and 9.0%, respectively, indicating that infectious morbidity is the single most common complication after hysterectomy independent of mode of surgery (2).

Various preventive measures such as the use of prophylactic antibiotics have been taken to reduce the morbidity. Other preventive measures are often carried out concomitantly with the use of prophylactic antibiotics but these are rarely adjusted for in the results of studies describing the effect of the prophylactic antibiotics on postoperative infectious morbidity in hysterectomy. One of these measures is vaginal cleansing. In a recently published study we presented findings on the influence of vaginal cleansing on infectious morbidity in abdominal total hysterectomy that showed that vaginal cleansing using chlorhexidine solution was not superior to hysterectomy without any vaginal cleansing (3). Quite to the contrary, vaginal cleansing using saline solution was associated with a significantly higher rate of cases of postoperative infectious morbidity than occurred if there was no use of vaginal cleansing or if chlorhexidine solution was used. Vaginal cleansing is commonly used in the preoperative preparation in hysterectomy, independent of mode of surgery. Despite a lack of scientific evidence of efficacy vaginal preparation is advocated in some text books in gynecological surgery (4,5). Very few randomized studies have been published concerning vaginal cleansing in hysterectomy (6-10). Furthermore, no general conclusion can be made from these trials since none of them have compared results of antiseptic use with results from cleansing using saline solution or no cleansing at all. Amstey and Jones in 1981 suggested that cleansing with saline solution would reduce the number of bacteria by simple dilution (11).

In Sweden, vaginal cleansing is not consistently used in the preoperative vaginal preparation before hysterectomy and the mode of cleansing varies between hospitals. The aims of this study were to evaluate whether preoperative vaginal preparation routines influence postoperative infectious morbidity in vaginal hysterectomy and to analyze risk factors for postoperative infectious morbidity.

Material and methods

This study is based on data extracted from the Swedish National Register for Gynecological Surgery and retrospectively collected information from the clinics about preoperative vaginal preparation routines.

The data used were the prospectively collected data in the Register of the cohort of women undergoing vaginal and laparoscopically assisted vaginal hysterectomy for benign conditions between January 1, 2000 and February 1, 2008. In May 2008 an e-mail survey about vaginal preparation routines employed preoperatively for all cases of vaginal and laparoscopic assisted vaginal hysterectomy was sent to all 43 hospitals enrolling patients in the Register during the time period. Responses were received from all participating clinics. In the survey the clinics were asked to answer whether they routinely used vaginal cleansing preoperatively during the period and, if so, which disinfectant was used. If the vaginal preparation routine had changed during the study period the clinic was required to give information about when and how the change had been carried out.

In this study extracted data and the definitions of postoperative infectious morbidity were similar to those previously published in the Swedish National Register for Gynecological Surgery concerning hysterectomy on benign indications (3,12). Briefly, data were collected prospectively using doctors' forms and patient questionnaires. Demographic, clinical and surgical data were accumulated pre-, per- and postoperatively for all patients during the hospital stay. At discharge data were registered about postoperative infectious morbidity and treatments during the hospital stay comprising 1) febrile morbidity (temperature $>38^{\circ}\text{C}$ for > 2 days); 2) abdominal wall wound infection; 3) vaginal cuff infection; 4) lower urinary tract infection (UTI); 5) upper UTI; 6) intra abdominal infection; and 7) sepsis.

The clinic routinely sent postoperative questionnaires to the patient approximately 6 to 8 weeks after the hysterectomy and the completed questionnaires were returned to the clinic. The questionnaire dealt with questions about postoperative infections and treatment from time of the operation to completion of the questionnaire. The options for answering the questions about postoperative infectious morbidity were *a*) having had temperature more than 38°C for more than 2 days after the operation; occurrence of: *b*) urinary tract infections; *c*) pelvic infection with purulent discharge; *d*) wound infection; *e*) pelvic abscess; *f*) sepsis; *g*) other infections; or *h*) no infections in the postoperative period. For treatment of postoperative complications the options were: *I*) no treatment; *II*) follow-up visit and/or further investigations; *III*) treatment with antibiotics; *IV*) treatment with analgesics; *V*) wound bandaging and dressing; and *VI*) other treatment. The patient could indicate more than one alternative answer to these questions.

In this study only those with postoperative infections registered at discharge from the hospital or who indicated at least one of the alternatives *b* to *f* in the postal questionnaire and were treated with antibiotics according to the questionnaire or registered by the physician in follow-up visits, were considered to have postoperative infectious morbidity. The postoperative infectious morbidity was categorized as postoperative infection (UTI not included), UTI, and no infection. Consequently, since an individual could have a postoperative infection (UTI excluded) concomitant with a UTI, overall postoperative infection was defined as a condition with either postoperative infection (UTI not included) or UTI.

Details of Ethics Approval

The study was approved by the Regional Ethics Board of Linköping University (Registration nr M19-07; amendment T4-09). Date of approval January 24; 2007 and for the amendment January 9, 2008).

Statistical analysis

Statistical analyses were performed using Statview[®], version 5.01 (SAS Institute Inc. SAS Campus Drive Cary, NC 27513). Ordinal data are presented as number and frequency, and continuous data as mean and standard deviation (SD). In the univariate analyses Student's-test (two-sided) was used for continuous data and Yates χ^2 tests or Fishers exact test for ordinal data. Multiple logistic regression analyses models were used to analyze associations between independent variables influencing occurrence of postoperative infectious morbidity. In these models, adjustments were carried out for known or potential confounding factors of postoperative infectious morbidity: age, BMI, smoking, concomitant POP surgery, per-operative bleeding volume, operation time, duration of hospital stay, and use of prophylactic antibiotics. The multivariate analyses were conducted in two steps. First, the above mentioned confounding factors were entered simultaneously in the models. Secondly, additional potential confounding factors were analyzed in the above mentioned models by testing them one by one in order to evaluate the predictive value of these factors in the occurrence of overall postoperative infectious morbidity at long term.

The results are presented as odds ratios (ORs) with 95% confidence interval (CI). Level of significance was set at $p < 0.05$.

Results

The flow chart (Figure 1) illustrates the study population and the distribution of mode of vaginal preparations at enrolment, at discharge from hospital and at 6-8 weeks follow-up.

Forty three clinics reported data to the Register during the study period. Forty one of the 43 clinics had consistent routines concerning vaginal preparation according to the e-mail survey. In the remaining two clinics the vaginal preparation was left to the surgeon's discretion. Since no information about vaginal preparation was available in the individual case, these two clinics were excluded from the study. Eventually the study population comprised the 6 496 women for whom there was information about vaginal cleansing.

Six (14.6%) of the 41 clinics did not use vaginal cleansing preoperatively, five (12.2%) used saline solution and 30 (73.2%) used chlorhexidine solution. During the study period, two clinics changed from using chlorhexidine to using saline solution and two clinics altered from using chlorhexidine to not performing vaginal cleansing preoperatively. The median number of women enrolled in the study from each clinic was 100 (range 1 – 1 009).

Table 1 shows the demographic and clinical data of the study population subdivided according to type of vaginal cleansing. Statistically significant differences were found between groups in several aspects.

The infectious morbidity registered during the hospital stay in relation to mode of vaginal cleansing is presented in Table 2. The infectious morbidity rate registered at discharge from hospital was 1.8% (117/6 393). Only vaginal cleansing using saline solution deviated statistically significantly and was a risk factor for lower and upper urinary tract infection and for infectious morbidity overall.

At follow-up the overall postoperative infectious morbidity rate was 13.2% (773/5 802). No significant differences were found in postoperative infectious morbidity rates between the three different routines of preoperative vaginal preparation (Table 3).

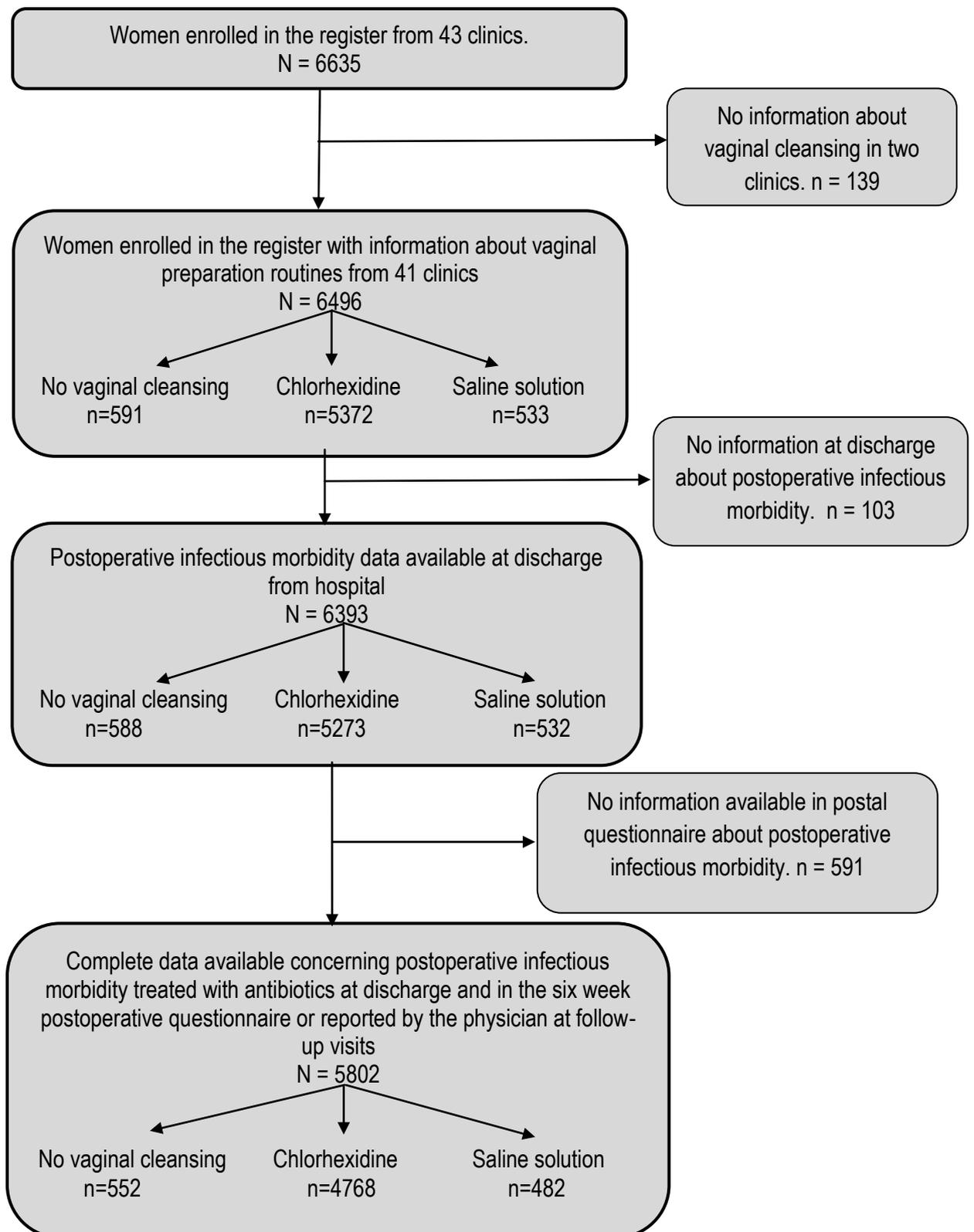


Figure I. Flowchart of women who underwent vaginal hysterectomy and laparoscopic assisted vaginal hysterectomy on benign indications in the Swedish National Register of Gynecological Surgery during the period January 1, 2000 to February 1, 2008.

The results of the multivariate analyses concerning predictive factors for postoperative infectious morbidity are shown in Table 4. Young age (< 40 years of age), obesity, operation time exceeding 90 minutes, peroperative injury of the urinary bladder, and duration of hospital stay exceeding 2 days, were statistically significant risk factors. Contrarily, prophylactic antibiotics and concomitant POP surgery, in particular concomitant anterior repair, were strong protective factors for postoperative infectious morbidity. Calendar year of the operation was not associated the rate of infections significantly (data not shown). By adding the hospitals who enrolled more than 20 patients in the Register during the study period (i.e. 38 clinics) as a confounding factor into the multivariate analysis model eight of these clinics had statistically significantly lower infection rates (OR´s between 0.21 and 0.49) than the reference. Five of these eight clinics enrolled each more than 200 women in the study and all used chlorhexidine for vaginal cleansing. In the statistical analysis none of the clinics had a statistically significantly higher infection rate than the reference.

Discussion

The results of this study imply that preoperative vaginal cleansing using chlorhexidine or saline solution does not seem to reduce the overall postoperative infectious morbidity in vaginal hysterectomy more than not using vaginal cleansing. However, using saline solution for vaginal cleansing seems to increase the risk of infectious morbidity nearly three-fold in the immediate postoperative period. This is particularly true for urinary tract infections.

The study confirmed that prophylactic antibiotics reduce the risk of postoperative infections after hysterectomy, and obesity and younger age increase the risk.

This retrospective study is based on data from the Swedish National Register for Gynecological Surgery which has registered data prospectively on hysterectomy for benign conditions since 1996. Several papers have been published based on data from the Register, a source (the Register) that has been well described and evaluated (3,12-16). The completeness of data and the questionnaires in the Register is high (3,12,15). Epidemiologic retrospective studies always include certain inherent limitations such as bias or lack of information. No information was given concerning delayed postoperative infectious morbidity of the non-responders of the 6-8 weeks postoperative questionnaire in the Register. This may be a bias in the study since the analysis has been done with the assumption that the non-responders were missing completely at random. The results should consequently be interpreted accordingly.

In this study the information about mode of preoperative vaginal preparation was collected retrospectively and reported by the clinics whereas information in the Register is reported on an individual basis. This may be a source of bias in the study. However, in Sweden preoperative vaginal preparation is usually carried out by the operation room nurse. This results in high compliance in conduction of the routine. In two clinics the decision of whether and how vaginal preparation should be carried out was decided by the surgeon in the individual case. These clinics were therefore excluded from the study.

The study population was heterogeneously distributed regarding demographic and clinical data as shown in Table 1. This suggests that the populations may vary in the catchment areas of the hospitals or the clinics may have different selection criteria for performing vaginal or laparoscopic assisted vaginal hysterectomy. It is striking that the study population in the clinics that did not use preoperative vaginal cleansing had a higher BMI and had used prophylactic antibiotics to a lesser degree. These issues could probably systematically influence the occurrence of postoperative infections. It is therefore necessary to adjust the results for these obvious confounding factors. Consequently, the size of the study population and use of multivariate statistic models with adjustment for confounding factors strengthen the interpretation of the results.

Through literature search in electronic media we found no randomized studies of vaginal cleansing in vaginal hysterectomy comparing either different antiseptics or antiseptics and placebo with infectious morbidity as outcome measure. Only one randomized study by Culligan *et al.* (17) compared two antiseptics (povidone iodine and chlorhexidine) in vaginal hysterectomy. The primary end point in that study was the proportion of contaminated specimens per group throughout the surgical procedure. At each time interval (30, 60 and 150 minutes after vaginal scrub) the proportion of contaminated specimens was lower in the chlorhexidine group but only at the 30 minutes sample the difference reached statistically significance, probably due to a low number of participants in the study. No infectious morbidity was observed between two and six weeks after the operation. The study was inconclusive concerning determination of which method was best to reduce infectious morbidity. The authors' conclusion was to ask the question: "Why not use an antiseptic that make the operative field cleaner since the purpose of the scrub is to reduce the number of pathogens in the operative field?"

The evidence that supported the use of chlorhexidine as a vaginal preparation to reduce infections has mainly been based on studies in obstetrics analyzing the effect of vaginal chlorhexidine disinfection during labour for the prevention of peripartal infections (18,19). In the present study no information is given about which dilution of chlorhexidine that was used, how the vaginal preparation was done or when it was carried out. These factors may be of importance in determining the nature of the antiseptic effect and the effect on postoperative infectious morbidity (17).

We found no significant difference in overall postoperative infectious morbidity between women who had had vaginal cleansing using chlorhexidine and non-users of vaginal cleansing but in the immediate postoperative period vaginal cleansing using saline solution fell out as a significant risk factor for infections, in particular urinary tract infections. These results cohere with those of our previous study concerning vaginal cleansing and abdominal total hysterectomy (3). The overall postoperative infectious morbidity rate in this study was similar to that reported for abdominal hysterectomy (3). This however seems to contradict the results of the Cochrane Review by Nieboer *et al.* (1), where the rate is higher after abdominal hysterectomy.

Urinary tract infections are common after insertion of indwelling catheters. In the present study no information is available in the Register about perioperative use or duration of use of the catheter or about the routine of periurethral cleansing. Bacteria can get into the catheterized bladder by direct inoculation at the time of catheter insertion and extraluminally by ascending from the urethral meatus along the catheter-urethral interface, and intraluminally by reflux of the organisms into the catheter lumen (20). However, it seems that urethral meatus cleansing using antiseptic or water before insertion of the catheter does not reduce the risk of bacteriuria (21). The increased risk of urinary tract infection after vaginal cleansing using saline solution as seen in this study can therefore hardly be explained by concomitant

cleansing of the periurethral area with saline. Instead it may be plausible that the vaginal flora may be disturbed in the recovery after vaginal cleansing by the dilution effect of the saline (11) leading to an initial predominance of bacteria other than lactobacilli which may be more prone to ascending along the catheter surface and be more pathogenic for the urinary tract.

An essential factor in the development of postoperative infectious morbidity in abdominal hysterectomy is the magnitude of bacterial contamination from the vagina during the surgery (22). Despite an obvious higher risk for bacterial contamination of the pelvis by the vaginal manipulation during the vaginal surgery we could not verify any increased risk of pelvic infections in women who had no vaginal cleansing compared with those who had cleansing. There may be some selection bias since cases with obvious preoperative vaginal infections such as bacterial vaginosis would be treated for a longer time with antibiotics and not simply with antibiotic prophylaxis. This issue is not dealt with specifically in the Register.

In accordance with other studies this study confirms that age, BMI, prophylactic antibiotics, peroperative injury of the urinary bladder, and duration of hospital stay are independent risk factors for infectious morbidity after hysterectomy (12,23,24). Smoking habits has been shown to be a significant risk factor for perioperative complications including infections in surgery including pelvic reconstructive surgery (25,26). In this study smoking habits were not an independent risk factor for infections. Because of the minimally invasive character of vaginal hysterectomy the negative systemic effects of tobacco smoking on the healing (25) may not exceed the limits for an uncomplicated healing process.

We found a significant association between postoperative infections and operative time in vaginal hysterectomy. This is contrary to what has been observed in abdominal hysterectomy (3,12,24). The reason for this may be that the surgical field in vaginal hysterectomy is exposed to the vaginal flora during entire operation and surgical and instrumental manipulations are carried out in the vagina. In abdominal hysterectomy the time

elapsed with an open vagina is usually relatively short and occurs late in the operation. The potential magnitude of contamination is therefore greater in vaginal hysterectomy than in the abdominal equivalent and consequently increases the risk of infection as emphasized by Houang *et al.* (22).

The risk of postoperative infections was lower in women who had concomitant prolapse surgery to the vaginal hysterectomy than in those who had vaginal hysterectomy alone when adjusted for confounding factors. This is in contrast to the findings of Heisler *et al.* who found a significantly higher complication rate including infections when concomitant reconstructive pelvic surgery was performed concomitant to the vaginal hysterectomy (27). It was in particular the group of women who had anterior colporrhaphy concomitant with the vaginal hysterectomy who had a lower risk of postoperative infections. This encompassed occurrence of urinary tract infections as well as other infections. We have no reasonable explanation for this finding and believe it probably may be a result of multiple testing.

Shubair *et al.* found that the recovery of the normal vaginal flora after daily vaginal douche using chlorhexidine for seven days occurred within 30 days and no untoward effects were seen in the study group of 20 healthy volunteers (28). Whether this result can be translated to the use of a single dose of chlorhexidine for vaginal cleansing followed by vaginal surgery is not known. Even though severe allergic reactions rarely occur, they have been described after topic application of chlorhexidine on skin (29) and desquamating vaginal reaction after vaginal cleansing have been reported (30). Whether vaginal cleansing can be omitted or vaginal cleansing should be carried out using chlorhexidine or saline solution needs further investigations. Preferably, a randomized study should be conducted to give an answer to the question. As judged by the infection rates presented here such study seems possible to carry out with sufficient statistical power in a multicenter setting.

In conclusion this study indicates that saline solution should not be used for vaginal cleansing before vaginal hysterectomy due to a higher risk of postoperative infectious morbidity in the immediate postoperative period. Infectious morbidity may be reduced further by employing preventive measures such as meticulous surgical technique to reduce operation time and peroperative complications, weight reduction in obese women prior to hysterectomy and minimizing time spent in hospital. Until more information about the influence of vaginal cleansing prior to vaginal hysterectomy is available we, in contrast with Culligan *et al.* (17), who stated: “Why not use the antiseptic that seems to make the operative field cleaner?” raise the question: “Why use vaginal cleansing in vaginal hysterectomy if it does not reduce the infection rate postoperatively and the patient runs a risk of side effects?”

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Disclosure of Interests

Preben Kjølhede and Shefqet Halili have no conflicts of interests to report. Mats Löfgren is Chairman of the Swedish National Register for Gynecological Surgery.

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References

1. Nieboer TE, Johnson N, Lethaby A, Tavender E, Curr E, Garry R, *et al.* Surgical approach to hysterectomy for benign gynaecological disease. *Cochrane Database Syst Rev.* 2009 Jul 8;(3):CD003677.
2. Mäkinen J, Johansson J, Tomás C, Tomás E, Heinonen PK, Laatikainen T *et al.* Morbidity of 10110 hysterectomies by type of approach. *Hum Reprod.* 2001;16:1473-8.
3. Kjølhede P, Halili S, Löfgren M. The influence of preoperative vaginal cleansing on postoperative infectious morbidity in abdominal total hysterectomy for benign indications. *Acta Obstet Gynecol Scand.* 2009;88(4):408-16.
4. Käser O, Iklé FA, Hirsch HA. *Atlas of Gynecological Surgery.* Ed. EA Friedman. 2nd revised and enlarged edition. Georg Thieme Verlag. Stuttgart – New York; Thieme-Statton Inc. New York; 1985; p 1.1.
5. Rock JA. Preoperative Care. In: *TeLinde's Operative Gynecology.* Eds. Thompson JD, Rock JA. 7th edition. JB Lippincott Company. Philadelphia. 1992;82-5.
6. Eason E L. Vaginal antiseptics for hysterectomy: a review of the literature. *Dermatology.* 1997;195(Supplement 2):53-6.
7. Vinkomin V. Vaginal scrub prophylaxis in abdominal hysterectomy. *Southeast Asian J Trop Med Public Health.* 1995;26(1):188-92.
8. Eason EL, Sampalis JS, Hemmings R, Joseph L. Povidone-iodine gel vaginal antiseptics for abdominal hysterectomy. *Am J Obstet Gynecol.* 1997;176(5):1011-6.
9. Buppasiri P, Chongsomchai C, Wongproamas N, Ounchai J, Suwannachat B, Lumbiganon P. Effectiveness of vaginal douching on febrile and infectious morbidities after total abdominal hysterectomy: a multicenter randomized controlled trial. *J Med Assoc Thai.* 2004;87(1):16-23.

10. Eason E, Wells G, Garber G, Hemmings R, Luskey G, Gillett P, *et al.* Antisepsis for abdominal hysterectomy: a randomised controlled trial of povidone-iodine gel. *BJOG*. 2004;111(7):695-9.
11. Amstey MS, Jones AP. Preparation of the vagina for surgery. A comparison of povidone-iodine and saline solution. *JAMA*. 1981;245(8):839-41.
12. Löfgren M, Poromaa IS, Stjerndahl JH, Renström B. Postoperative infections and antibiotic prophylaxis for hysterectomy in Sweden: a study by the Swedish National Register for Gynecologic Surgery. *Acta Obstet Gynecol Scand*. 2004;83:1202-7.
13. Ladfors MB, Löfgren ME, Gabriel B, Olsson JH. Patient accept questionnaires integrated in clinical routine: a study by the Swedish National Register for Gynecological Surgery. *Acta Obstet Gynecol Scand*. 2002;81:437-42.
14. Dueholm M, Rokkones E, Löfgren M, Härkki P, Arason G. Nordic gynecologists' opinion on quality assessment registers. *Acta Obstet Gynecol Scand*. 2004;83:563-9.
15. Pakbaz M, Mogren I, Löfgren M. Outcomes of vaginal hysterectomy for uterovaginal prolapse: a population-based, retrospective, cross-sectional study of patient perceptions of results including sexual activity, urinary symptoms, and provided care. *BMC Womens Health*. 2009;9:9.
16. Publications from the Swedish National Register for Gynecological Surgery (in Swedish). <http://www.gynop.org>
17. Culligan PJ, Kubik K, Murphy M, Blackwell L, Snyder J. A randomized trial that compared povidone iodine and chlorhexidine as antiseptics for vaginal hysterectomy. *Am J Obstet Gynecol*. 2005;192(2):422-5.
18. Adriaanse AH, Kollée LA, Muijtens HL, Nijhuis JG, de Haan AF, Eskes TK. Randomized study of vaginal chlorhexidine disinfection during labor to prevent vertical

- transmission of group B streptococci. *Eur J Obstet Gynecol Reprod Biol.* 1995;61(2):135-41.
19. Rouse DJ, Hauth JC, Andrews WW, Mills BB, Maher JE. Chlorhexidine vaginal irrigation for the prevention of periparturient infection: a placebo-controlled randomized clinical trial. *Am J Obstet Gynecol.* 1997;176(3):617-22.
 20. Tambyah PA, Halvorson KT, Maki DG. A prospective study of pathogenesis of catheter-associated urinary tract infections. *Mayo Clin Proc.* 1999;74(2):131-6.
 21. Webster J, Hood RH, Burrige CA, Doidge ML, Phillips KM, George N. Water or antiseptic for periurethral cleaning before urinary catheterization: a randomized controlled trial. *Am J Infect Control.* 2001;29(6):389-94.
 22. Houang ET, Ahmet Z. Intraoperative wound contamination during abdominal hysterectomy. *J Hosp Infect.* 1991;19(3):181-9.
 23. Ledger WJ. Prophylactic antibiotics in obstetrics-gynecology: a current asset, a future liability? *Expert Rev Anti Infect Ther.* 2006;4(6):957-64.
 24. Peipert JF, Weitzen S, Cruickshank C, Story E, Ethridge D, Lapane K. Risk factors for febrile morbidity after hysterectomy. *Obstet Gynecol.* 2004;103:86-91.
 25. Møller A, Tønnesen H. Risk reduction: perioperative smoking intervention. *Best Pract Res Clin Anaesthesiol.* 2006;20(2):237-48.
 26. Lowman JK, Woodman PJ, Nosti PA, Bump RC, Terry CL, Hale DS. Tobacco use is a risk factor for mesh erosion after abdominal sacral colpoproctopexy. *Am J Obstet Gynecol.* 2008;198(5):561.e1-4.
 27. Heisler CA, Weaver AL, Melton LJ 3rd, Gebhart JB. Effect of additional reconstructive surgery on perioperative and postoperative morbidity in women undergoing vaginal hysterectomy. *Obstet Gynecol.* 2009;114(4):720-6.

28. Shubair M, Stanek R, White S, Larsen B. Effects of chlorhexidine gluconate douche on normal vaginal flora. *Gynecol Obstet Invest.* 1992;34(4):229-33.
29. Lim KS, Kam PC. Chlorhexidine--pharmacology and clinical applications. *Anaesth Intensive Care.* 2008;36(4):502-12.
30. Shippey SH, Malan TK. Desquamating vaginal mucosa from chlorhexidine gluconate. *Obstet Gynecol.* 2004;103(5 Pt 2):1048-50.

Table 1. Demographic and clinical data from 6496 women with vaginal or laparoscopically assisted vaginal total hysterectomy on benign indications subdivided according to mode of preoperative vaginal cleansing.

Characteristic		A	B	C	Univariate analyses		
		No vaginal cleansing (n = 591)	Vaginal cleansing using chlorhexidine (n = 5372)	Vaginal cleansing using saline (n = 533)	p-value A vs. B	p-value A vs. C	p-value B vs. C
Age (years)		55.7 ± 12.8	51,1 ± 11.8	55.5 ± 12.7	<0.0001	0.7903	<0.0001
Age groups	< 40	54 (9%)	683 (13%)	48 (9%)	<0.0001*	0.9832*	<0.0001*
	≥ 40 and < 50	170 (29%)	2322 (43%)	155 (29%)			
	≥ 50 and < 60	146 (25%)	1177 (22%)	136 (26%)			
	≥ 60	221 (37%)	1190 (22%)	194 (36%)			
BMI (kg/m ²)		26.1 ± 4.2	25.6 ± 4.2	26.0 ± 3.9	0.0093	0.6737	0.0479
BMI groups	< 25	234 (45%)	2506 (51%)	217 (45%)	0.0248	0.9376	0.0578
	≥25 and <30	209 (40%)	1707 (35%)	188 (39%)			
	≥ 30	77 (15%)	705 (14%)	74 (16%)			
Smoking	Yes	97 (18%)	1309 (26%)	87 (17%)	0.0001‡	0.8042‡	<0.0001‡
	No	446 (72%)	3815 (74%)	422 (83%)			
Mode of hysterectomy	Vaginal	578 (98%)	4790 (89%)	520 (98%)	<0.0001‡	0.9459‡	<0.0001‡
	LAVH	13 (2%)	582 (11%)	13 (2%)			
Concomitant POP surgery	Yes	333 (56%)	1589 (30%)	250 (47%)	<0.0001‡	0.0019‡	<0.0001‡
	No	258 (44%)	3783 (70%)	283 (53%)			
Duration of surgery (minutes)		79.6 ± 35.5	73.9 ± 33.9	73.9 ± 32.0	<0.0001	0.0051	0.9905
Bleeding volume (mL)		137 ± 171	149 ± 175	158 ± 150	0.1452	0.0338	0.2282
Peroperative organ injury	Urinary bladder	4 (0.7%)	50 (0.9%)	6 (1.1%)	0.6530†	0.5313†	0.6403†
	Intestinal	0 (0%)	2 (0.04%)	0 (0%)	1.0000†	1.0000†	1.0000†
	Ureter	2 (0.3%)	4 (0.07%)	0 (0%)	0.1148†	0.5008†	1.0000†
Weight of uterus (g)		152 ± 103	165 ± 123	149 ± 92	0.0798	0.7443	0.0261
Use of antibiotic prophylaxis	Yes	430 (73%)	4866 (91%)	405 (76%)	<0.0001♦	0.2866♦	<0.0001♦
	No	154 (26%)	346 (6%)	119 (22%)			
	No information	7 (1%)	160 (3%)	9 (2%)			

Blood transfusion (no. of patients)	Yes	2 (0.3%)	30 (0.6%)	3 (0.6%)	<0.0001 [♦]	0.0044 [♦]	0.4138 [♦]
	No	578 (97.8%)	4968 (92.5%)	501 (94.0%)			
	No information	11 (1.9%)	374 (6.9%)	29 (5.4%)			
Duration of hospital stay (days)		1.9 ± 2.5	2.1 ± 1.8	2.7 ± 3.1	<0.0001	<0.0001	<0.0001

Figures are mean ± 1 standard deviation (SD) or number and (%).

BMI = body mass index; LAVH = laparoscopically assisted vaginal hysterectomy; POP = pelvic organ prolapse.

Information about characteristics is partially lacking for some patients.

* Yates χ^2 test; df = 3. [♦] Yates χ^2 test, df = 2. [‡] Yates χ^2 test; df = 1. [†] Fishers exact test. Student's t-tests are used for comparing continuous variables between the groups.

Table 2. Associations between mode of vaginal cleansing and postoperative infectious morbidity registered at discharge from hospital in 6393 women.

	Infectious morbidity	Proportion registered as treated with antibiotics or penicillin at discharge	Mode of vaginal cleansing	No. of women with the infectious morbidity (n and (%))	OR and (95% CI)*
A	Fever > 38° C >2 days	76% (45/59)	No vaginal cleansing	2 (0.34%)	0.19 (0.02 – 1.59)
			Chlorhexidine	48 (0.91%)	1 (reference)
			Saline	9 (1.69%)	1.74 (0.72 – 4.19)
B	Lower UTI	96% (71/74)	No vaginal cleansing	7 (1.19%)	1.00 (0.41 – 2.47)
			Chlorhexidine	49 (0.93%)	1 (reference)
			Saline	18 (3.38%)	3.82 (2.08 – 6.99)
C	Upper UTI	100% (3/3)	No vaginal cleansing	0 (0%)	NA
			Chlorhexidine	1 (0.02%)	1 (reference)
			Saline	2 (0.38%)	20.46 (1.49 – 280.46)
D	Vaginal cuff infection	86% (30/35)	No vaginal cleansing	2 (0.34%)	1.41 (0.31 – 6.36)
			Chlorhexidine	30 (0.57%)	1 (reference)
			Saline	3 (0.56%)	0.83 (0.16– 4.37)
E	Abdominal wound infection	100% (1/1)	No vaginal cleansing	0 (0%)	NA
			Chlorhexidine	1 (0.02%)	NA
			Saline	0 (0%)	NA
F	Intra abdominal infection	57% (4/7)	No vaginal cleansing	0 (0%)	NA
			Chlorhexidine	7 (0.13%)	NA
			Saline	0 (0%)	NA
G	Sepsis	0% (0/0)	No vaginal cleansing	0 (0%)	NA
			Chlorhexidine	0 (0%)	NA
			Saline	0 (0%)	NA
B-G	Any infectious morbidity#	91% (106/117)	No vaginal cleansing	9 (1.53%)	0.96 (0.44 – 2.12)
			Chlorhexidine	86 (1.63%)	1 (reference)
			Saline	22 (4.14%)	2.96 (1.74 – 5.04)

CI = confidence interval. NA = not applicable. OR = odds ratio. POP = pelvic organ prolapse. UTI = urinary tract infection. *Adjusted for age, BMI, smoking, peroperative bleeding volume, operative time, duration of hospital stay, concomitant POP surgery, and use of prophylactic antibiotics. # A woman may have more infections.

Table 3. Associations between mode of vaginal cleansing and postoperative infectious morbidity treated with antibiotics registered by the physician at discharge from the hospital or at follow up visits, or by the patient in the postal questionnaire for 5802 women.

Mode of vaginal cleansing	Postoperative infections (UTI not included)		UTI		Overall postoperative infections	
	Number of cases and (%)	OR and (95% CI)*	Number of cases and (%)	OR and (95% CI)*	Number of cases and (%)	OR and (95% CI)*
No vaginal cleansing (n=552)	47 (8.5%)	1 (reference)	35 (6.3%)	1 (reference)	70 (12.7%)	1 (reference)
Chlorhexidine (n=4768)	465 (9.8%)	1.07 (0.75-1.52)	284 (6.0%)	1.04 (0.69-1.57)	638 (13.5%)	1.00 (0.74–1.35)
Saline solution (n=482)	42 (8.7%)	0.95 (0.59-1.55)	34 (7.1%)	1.15 (0.67-1.97)	65 (13.5%)	1.00 (0.67-1.49)

UTI = urinary tract infection. POP = pelvic organ prolapse. BMI = body mass index

Overall postoperative infection was defined as a condition with either postoperative infection (UTI not included) or UTI.

*Adjusted for age, BMI, smoking, peroperative bleeding volume, operative time, duration of hospital stay, concomitant POP surgery, and use of prophylactic antibiotics.

Table 4. Predictive factors for postoperative infectious morbidity treated with antibiotics after vaginal hysterectomy on benign indication.

Predictive factor		OR and (95% CI)*	P-value
Mode of hysterectomy	Vaginal	1 (reference)	
	LAVH	0.93 (0.59 – 1.25)	0.6296
Age groups (years)	< 40	1 (reference)	
	≥ 40 and < 50	0.76 (0.59 – 0.97)	0.0273
	≥ 50 and < 60	0.56 (0.41 – 0.76)	0.0002
	≥ 60	0.63 (0.44 – 0.89)	0.0068
BMI groups (kg/m ²)	< 25	1 (reference)	
	≥25 and <30	1.18 (0.98 – 1.41)	0.0829
	≥ 30	1.29 (1.01 – 1.63)	0.0402
Smoking	No	1 (reference)	
	Yes	1.03 (0.84 – 1.25)	0.7810
Duration of surgery (min)	< 60	1 (reference)	
	≥ 60 and < 90	1.13 (0.92 – 1.38)	0.2439
	≥ 90	1.31 (1.05 – 1.65)	0.0180
Volume of bleeding (ml)	< 100	1 (reference)	
	≥ 150 and < 500	1.17 (0.96 – 1.42)	0.1158
	≥ 500	0.88 (0.57 – 1.38)	0.5795
Blood transfusion	No	1 (reference)	
	Yes	1.39 (0.49 – 3.91)	0.5326
Peroperative injury of urinary bladder	No	1 (reference)	
	Yes	2.16 (1.10 – 4.24)	0.0246
Weight of uterus (g)	< 300	1 (reference)	
	≥ 300	0.85 (0.61 – 1.17)	0.3113
Concomitant POP surgery	No	1 (reference)	
	Yes	0.71 (0.55 – 0.90)	0.0049
Mode of concomitant POP surgery	No POP surgery	1 (reference)	
	Anterior repair	0.65 (0.47 – 0.90)	0.0103
	Posterior repair	0.69 (0.38 – 1.26)	0.2250
	Complete repair	0.77 (0.58 – 1.02)	0.0676
Prophylactic antibiotics	No	1 (reference)	
	Yes	0.63 (0.47 – 0.84)	0.0019
Duration of hospital stay (days)	≤ 2	1 (reference)	
	3 – 5	1.71 (1.43 – 2.05)	< 0.0001
	> 5	5.88 (3.94 – 8.76)	< 0.0001

BMI = body mass index; POP = pelvic organ prolapse.

*Adjusted for age, BMI, smoking, peroperative bleeding volume, operative time, duration of hospital stay, concomitant POP surgery, use of prophylactic antibiotics, and mode of vaginal cleansing.